(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開2001－4850

（P2001－4850A）

(43)公開日　平成13年1月12日(2001.1.12)

(51)Int.Cl.⁷	識別記号	ＦＩ	テーマコード*(参考)
Ｇ０２Ｂ　6/12		Ｇ０２Ｂ　6/12	Ｎ　２Ｈ０４７
Ｃ０８Ｇ　73/10		Ｃ０８Ｇ　73/10	４Ｆ０７１
Ｃ０８Ｊ　5/18	ＣＦＧ	Ｃ０８Ｊ　5/18	ＣＦＧ　４Ｊ０４３
Ｇ０２Ｂ　1/04		Ｇ０２Ｂ　1/04	

審査請求　未請求　請求項の数７　ＯＬ　（全９頁）

(21)出願番号　特願平11－171414

(22)出願日　平成11年6月17日(1999.6.17)

(71)出願人　000004226
日本電信電話株式会社
東京都千代田区大手町二丁目３番１号

(71)出願人　000102739
エヌ・ティ・ティ・アドバンステクノロジ株式会社
東京都新宿区西新宿二丁目１番１号

(71)出願人　000219266
東レ・デュポン株式会社
東京都中央区日本橋本町１丁目５番６号

(74)代理人　100077481
弁理士　谷　義一　（外１名）

最終頁に続く

(54)【発明の名称】　光部品用基板とその製造方法、および該基板の熱膨張率制御方法

(57)【要約】

【課題】　表面の平滑性に優れ、かつ熱膨張係数が４×１０$^{-5}$／℃以上１．２×１０$^{-4}$／℃以下である、高分子光導波路用の高分子基板を簡便に作製できる光部品用基板およびその製造方法と、前記基板の熱膨張係数を部品材料に合わせて制御する方法とを提供する。

【解決手段】　表面が平滑な高分子薄膜を積層して良好な表面平滑性の積層体を形成し、この積層体を光部品用基板として適用する。さらに、１種類または熱膨張係数の異なる２種類以上のポリイミドフィルムを用い、これらを適当な順序で重ねた積層体を作製して、これを基板として用い、ポリイミドの化学構造および積層の構成を変化させることで、光部品用基板の熱膨張係数を幅広い範囲で制御する。

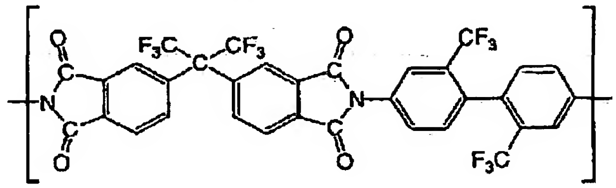
【特許請求の範囲】

【請求項１】　１種類または２種類以上の高分子フィルムが複数層積層されるとともに加熱圧着されてなる積層体からなる光部品用基板。

【請求項２】　前記積層体を構成する高分子フィルムがポリイミドであることを特徴とする請求項１記載の光部＊＊品用基板。

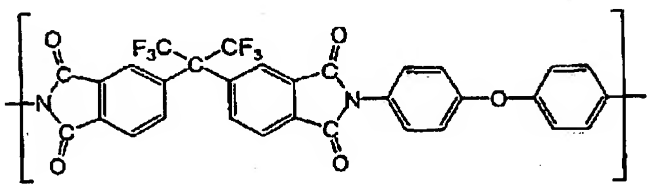
【請求項３】　前記積層体を構成する１種類または２種類以上の高分子フィルムとして、下記構造式（１）、（２）：

【化１】



（１）

【化２】

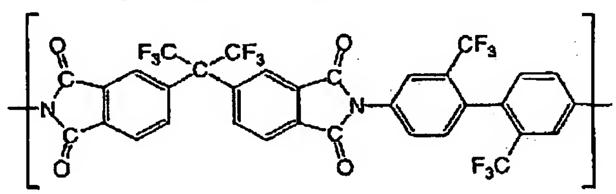


（２）

で表される繰り返し単位のいずれかからなるポリイミドフィルムまたは前記繰り返し単位の２種類以上からなる共重合ポリイミドフィルムを用いることを特徴とする請※※求項１記載の光部品用基板。

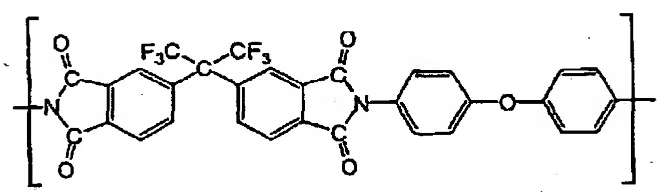
【請求項４】　下記構造式（１）、（２）：

【化３】



（１）

【化４】



（２）

で表される繰り返し単位のいずれかからなるポリイミドまたは前記繰り返し単位の２種類以上からなる共重合ポリイミドを用いて、ロール延伸法または溶液塗布法により１種類または２種類以上のポリイミドフィルムまたは共重合ポリイミドフィルムを作製し、

前記１種類または２種類以上のポリイミドフィルムまたは共重合ポリイミドフィルムを複数層に重ね、

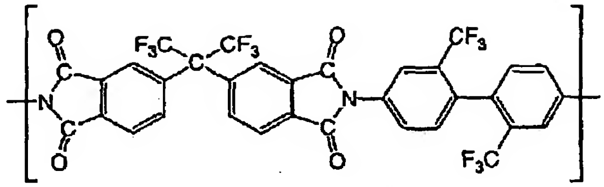
前記複数層に重ねたポリイミドフィルム積層体を加熱圧縮により一体化して光部品用の基板を得ることを特徴とする光部品用基板の製造方法。

【請求項５】　熱膨張率の異なる複数のポリイミドフィルムから１種類または２種類以上のポリイミドフィルムを選択して複数層積層し、これを加熱圧着して得られる光部品用基板の熱膨張率を制御する方法であって、

前記複数のポリイミドフィルムを積層する際に、前記１種類または２種類以上のポリイミドフィルムの積層順または／および積層数を変化させることにより、該基板の熱膨張率を所望値に制御することを特徴とする光部品用基板の熱膨張率制御方法。

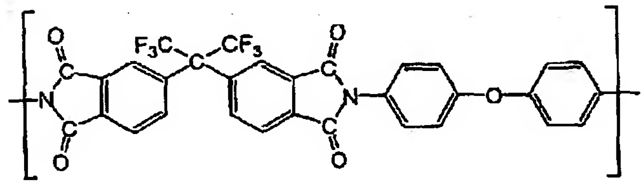
【請求項６】　前記１種類または２種類以上のポリイミドフィルムを構成するポリイミドのうちの１種類のポリイミドとして、下記構造式（１）、（２）：

【化５】



（1）

【化6】

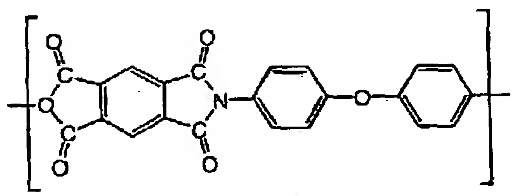


（2）

で表される繰り返し単位からなるポリイミドまたは前記繰り返し単位の２種類以上からなる共重合ポリイミドを用いることを特徴とする請求項５記載の光部品用基板の熱膨張率制御方法。 *

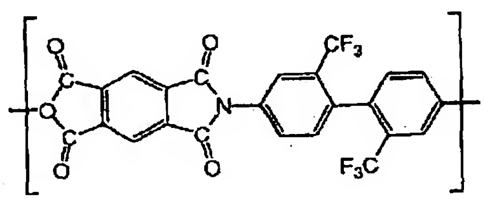
*【請求項７】　前記熱膨張率を制御するための低熱膨張率ポリイミドフィルムとして、下記構造式（３）または（４）：

【化7】



（3）

【化8】



（4）

で表される繰り返し単位からなるポリイミドのフィルムを用いることを特徴とする請求項６に記載の光部品用基板の熱膨張率制御方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、複数層の高分子フィルムを積層一体化してなる光部品用基板とその製造方法、および該基板の熱膨張率制御方法に関する。

【０００２】

【従来の技術】低損失光ファイバの開発による光通信システムの実用化に伴い、種々の光通信用部品の開発が望まれている。また、これら光部品を高密度に実装する光配線技術、特に光導波路技術の確立が望まれている。

【０００３】一般に、光導波路材料には、光損失が小さいこと、光導波路の作製が容易なこと、コアとクラッドの屈折率差を制御できること、耐熱性に優れていること、等の条件が要求される。光導波路材料として、これまでに最も精力的に検討されているのが石英系材料である。光ファイバで実証済のように、石英は光透過性が極めて小さく、光導波路とした場合も、波長が１．３μｍにおいて０．１ｄＢ／ｃｍ以下の低光損失化が達成されている。しかし、その光導波路には、作製に長時間を必要とする、作製時に高温が必要である、大面積化が困難であるなど、製造上の問題がある。

【０００４】これに対して、ポリメチルメタクリレートなどのプラスチック光学材料は、低い温度で光導波路形成が可能であり、低価格が期待できるなどの長所がある一方、耐熱性，耐湿性に劣るという欠点がある。また、ポリイミドはプラスチックの中で最も耐熱性に優れているが、従来のポリイミドは光透過性に劣るという問題があった。

【０００５】そこで、本発明者らはポリイミドの化学構造を検討することにより光透過性に優れたポリイミド光学材料の研究を行ってきた。本発明者らは特開平３－７２５２８号公報で光透過性に優れたフッ素化ポリイミドを明らかにしている。さらに、特開平４－８７３４号公報では、このフッ素化ポリイミドを共重合することにより、例えば、光導波路の形成に必要な屈折率制御が可能であることを明らかにしている。また、このフッ素化ポリイミドを用いた光導波路については、特開平４－９８

０７号公報、同４－２３５５０５号公報、同４－２３５５０６号公報で明らかにしている。このように光透過性に優れたポリイミドで耐熱性に優れたプラスチック光導波路が実現されている。

【０００６】しかしながら、ポリイミド光導波路においても、幾つかの問題がある。例えば、ポリイミドは耐熱性に優れている反面、化学構造中の芳香族環が配向し易いという面も持っている。これは、光学材料としてみた場合、複屈折を発現し易いということが言える。複屈折自体は、光学材料としてはある場合は好ましい特性であり、ある場合は好ましくない特性となる。また、光導波路用材料としてみた場合も、同じことが言える。例えば、直線偏光の偏波面を保存しながら導波させたい場合は、複屈折があった方が良いが、無偏波の光を導波させたい場合は、複屈折を持たない方が良い。このように、複屈折をいかようにも制御できることが期待されている。本発明者らのこれまでの検討により、このうち低複屈折ポリイミド膜については、基板の熱膨張係数とポリイミドの熱膨張係数を合わせること、すなわち、基板としてポリイミド基板を用いることにより低複屈折ポリイミド膜が実現できることを、見いだした（特願平７－１８７６５２号明細書）。このように光部品を作製するに当り、光導波路材料に合わせて、基板の熱膨張係数を制御することは高性能な光部品を作製するために極めて有効かつ重要な手法である。

【０００７】また、ＬＳＩ等の基板やモジュール基板、プリズム基板等の電子部品の回路基板においても、回路を構成する金属材料や絶縁材料に合わせて、基板の熱膨張係数を制御することは、電子部品の応力を低減し、部品の歩留まりや信頼性を大きく向上させることが期待できる。

【０００８】

【発明が解決しようとする課題】ところで、前述の光部品用基板には、以下のような問題点があることが明らかとなった。すなわち、ポリイミド基板上にポリイミド膜を形成する場合、低複屈折化は実現できるが、この基板上に作製したポリイミド光導波路は光を通しにくいという問題点が生じた。これはポリイミド基板が光学用途に適した基板ではないということが原因であると考えられる。そこで、本発明者らは、圧縮成型等で作製したポリイミド成型体から切り出したポリイミド基板の表面の平均粗さを５００Å以下に研磨することで光学用基板として適用できることを、特願平９－１８７１９４号明細書において、明らかにした。しかし、この方法では、成型直後のポリイミド成型体はその表面粗さが著しく大きいため、表面を平滑にするための研磨に長時間を要し、基板の製造コストが著しく高くなるという問題点を有していた。

【０００９】また、前述のように、光部品や電光部品の基板の熱膨張係数を制御することは部品の製造における歩留まりや部品の性能を向上する極めて効果的な方法であるが、これまで光部品（特に光学用ポリイミドを用いた光部品）や電子部品の作製に必要な熱処理に耐え得る材料を用いた基板で、簡便にその熱膨張係数を制御できる基板はなかった。

【００１０】したがって、本発明の第１の課題は、表面の平滑性に優れ、かつ熱膨張係数が$４×１０^{-5}$／℃以上$１．２×１０^{-4}$／℃以下である、高分子光導波路用の高分子基板を簡便に作製できる光部品用基板およびその製造方法を提供することにある。

【００１１】また、本発明の第２の課題は、光部品や電子部品の基板の熱膨張係数を部品材料に合わせて制御する方法を提供することにある。

【００１２】

【課題を解決するための手段】本発明者らは、光部品用の高分子基板の作製を鋭意検討した結果、表面が平滑な高分子薄膜を積層して得られる積層体が良好な表面平滑性を有し、この積層体が光部品用の基板として適用できることをつきとめた。さらに、本発明者らは、光部品、特にポリイミド光導波路に用いる基板や、電子部品の基板の熱膨張率制御方法について鋭意検討した結果、１種類または熱膨張係数の異なる２種類以上のポリイミドフィルムを用い、これらを適当な順序で重ねた積層体を作製して、これを基板として用い、ポリイミドの化学構造および積層の構成を変化させることで、光部品や電子部品の基板の熱膨張係数を幅広い範囲で制御できることを明らかにし、この積層体が光部品や電子部品用の基板として適用できることをつきとめた。本発明は、これら知見に基づいて成されたものである。

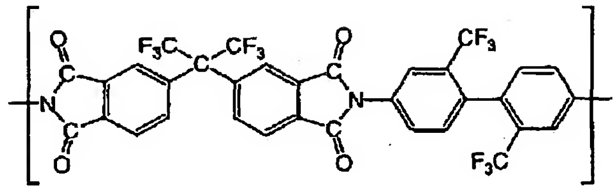
【００１３】すなわち、本発明を概説すれば、本発明の請求項１の光部品用基板は、１種類または２種類以上の高分子フィルムが複数層積層されるとともに加熱圧着されてなる積層体からなることを特徴とする。

【００１４】また、本発明の請求項２の光部品用基板は、前記請求項１の光部品用基板において、前記積層体を構成する高分子フィルムがポリイミドであることを特徴とする。

【００１５】また、本発明の請求項３の光部品用基板は、前記請求項１の光部品用基板において、前記積層体を構成する１種類または２種類以上の高分子フィルムとして、下記構造式（１）、（２）：

【００１６】

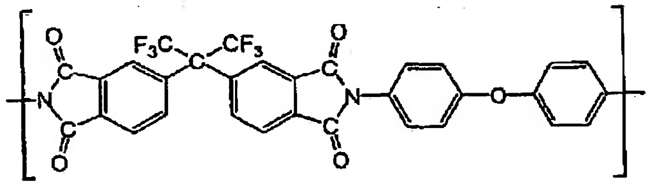
【化９】



(1)

【0017】 ＊

＊【化10】



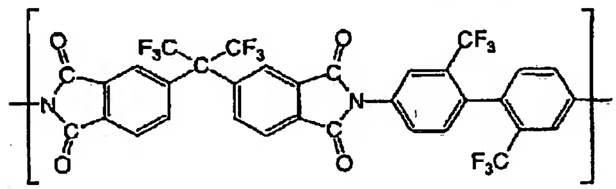
(2)

【0018】で表される繰り返し単位のいずれかからなるポリイミドのフィルムまたは前記繰り返し単位の２種類以上からなる共重合ポリイミドのフィルムを用いることを特徴とする。 ※

※【0019】また、本発明の請求項４の光部品用基板の製造方法は、下記構造式（１）、（２）：

【0020】

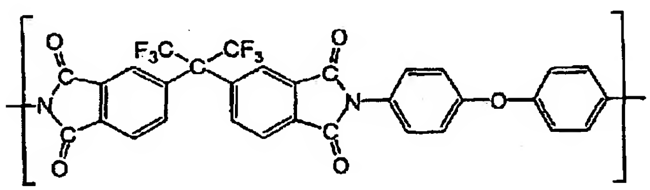
【化11】



(1)

【0021】 ★

★【化12】



(2)

【0022】で表される繰り返し単位のいずれかからなるポリイミドまたは前記繰り返し単位の２種類以上からなる共重合ポリイミドを用いて、ロール延伸法または溶液塗布法により１種類または２種類以上のポリイミドフィルムまたは共重合ポリイミドフィルムを作製し、前記１種類または２種類以上のポリイミドフィルムまたは共重合ポリイミドフィルムを複数層に重ね、前記複数層に重ねたポリイミドフィルム積層体を加熱圧縮により一体化して光部品用の基板を得ることを特徴とする。

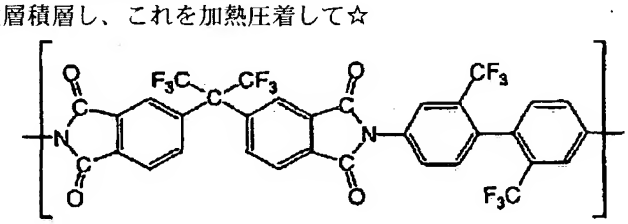
【0023】さらに、本発明の請求項５の光部品用基板の熱膨張率制御方法は、熱膨張率の異なる複数のポリイミドフィルムから１種類または２種類以上のポリイミドフィルムを選択して複数層積層し、これを加熱圧着して☆

☆得られる光部品用基板の熱膨張係数を制御する方法であって、前記複数のポリイミドフィルムを積層する際に、前記１種類または２種類以上のポリイミドフィルムの積層順または／および積層数を変化させることにより、該基板の熱膨張率を所望値に制御することを特徴とする。

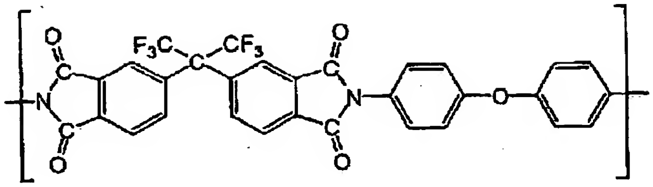
【0024】また、本発明の請求項６の光部品用基板の熱膨張率制御方法は、前記請求項５の制御方法において、前記１種類または２種類以上のポリイミドフィルムを構成するポリイミドのうちの１種類のポリイミドとして、下記構造式（１）、（２）：

【0025】

【化13】



(1)



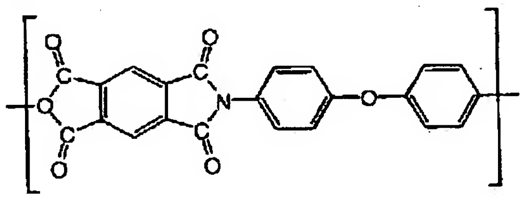
（2）

【0027】で表される繰り返し単位からなるポリイミドまたは前記繰り返し単位の２種類以上からなる共重合ポリイミドを用いることを特徴とする。

【0028】また、本発明の請求項７の光部品用基板の熱膨張率制御方法は、前記請求項６の制御方法において、前記熱膨張率を制御するための低熱膨張率ポリイミドフィルムとして、下記構造式（3）または（4）：

【0029】

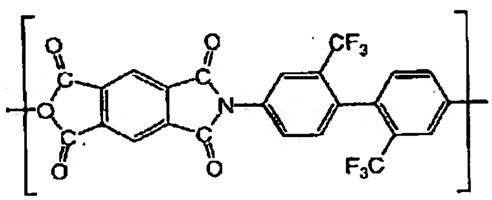
【化１５】



（3）

【0030】

【化１６】



（4）

【0031】で表される繰り返し単位からなるポリイミドのフィルムを用いることを特徴とする。

【0032】

【発明の実施の形態】以下、本発明を具体的に説明する。

【0033】本発明の光部品用基板に用いる高分子薄膜は、ロール延伸や溶液塗布法で得られた均一膜厚で表面の平滑性に優れた薄膜フィルムを使用することが可能である。高分子薄膜の材質については、膜厚が１０μm程度以上の薄膜形成が可能であって、加熱圧着や多層化等の手法により積層可能な材料であれば、特に制限はない。しかし、この高分子薄膜材料は、基板の熱安定性の観点からポリイミドがよく、さらに、ポリイミド光導波路に用いる積層体の材料としては、光導波路材料との熱膨張率整合の観点から前記構造式（1）、（2）で表される繰り返し単位からなるポリイミドフィルムまたは前記構造式で表されるイミド化合物を組み合わせて重合してなる共重合ポリイミドフィルム、または、熱膨張係数が4×10^{-5}／℃以上1.2×10^{-4}／℃以下であるポリイミドフィルムが好ましい。なぜなら、耐熱性に関しては、これらのポリイミドフィルムで作製したポリイミド基板上にポリイミド膜を形成することを予定しており、そのためにはポリアミド酸からポリイミドへ熱イミド化する時の温度に耐える必要があるからである。また、熱膨張係数に関しては、基板上に形成されるポリイ

／℃であるため、光導波路のひずみを防止するためには、光導波路部分と基板部分の熱膨張係数をある程度合わせておくことが必要となるためである。基板の熱膨張係数が4×10^{-5}／℃以上1.2×10^{-4}／℃以下の範囲から外れると、光導波路部分と基板部分の熱膨張係数差に基づく大きなひずみを生じて、光導波路に剥離やひび割れを引き起こし、また、光導波路の複屈折が著しく大きくなるといった不具合を生じることとなる。

【0034】これらの材料を用いた高分子薄膜を重ねて加熱圧着し、または複数回コーティングして、膜厚５００μm以上の積層体を作製する。

【0035】なお、前記積層体を構成するポリイミドフィルムとしては、その熱膨張率の制御範囲を広くするためには、ポリイミドの中でも熱膨張係数が非常に大きい前記構造式（1）または（2）で表される繰り返し単位からなるポリイミドを高熱膨張成分として用いることが好ましい。また、ポリイミド光導波路に用いる積層体の材料としては、光導波路材料との整合性の観点からも前記構造式（1）で表される繰り返し単位からなるポリイミドを用いることが好ましい。

【0036】また、２種類目の低熱膨張成分のポリイミドフィルムとしては、フィルムの製膜と積層後の加熱圧着が可能であって、前記構造式（1）で表される繰り返し単位からなるポリイミドより熱膨張率の小さいポリイミドであれば、特に分子構造の制限はなく、市販のポリ

式（３）で表される繰り返し単位からなるポリイミドは、汎用性が高く、低熱膨張成分のポリイミド材料として好適である。また、第２成分のポリイミドとして、さらに低熱膨張性を有するポリイミドを用いることで、積層体基板の熱膨張率はさらに広い範囲で制御可能となる。そのようなものとしては、前記構造式（４）で表される繰り返し単位からなるポリイミドが好適であり、またはそれ以外には、下記の酸無水物とジアミンから合成されるポリイミド等が挙げられる。酸無水物としては、ピロメリット酸二無水物、ビフェニルテトラカルボン酸二無水物、ベンゾフェノンテトラカルボン酸二無水物、等を挙げることができ、ジアミンとしては、パラフェニレンジアミン、メタフェニレンジアミン、２，２′－ジメチル－４，４′－ジアミノビフェニル、３，３′－ジアミノ－４，４′－ビフェニル、２，２′－ジトリフルオロメチル－４，４′－ジアミノビフェニル、４，４′－ジアミノビフェニル、４，４″－ジアミノ－Ｐ－テルフェニル等を用いたポリイミドを挙げることができる。

【００３７】また、前記構造式（３）（４）で表される繰り返し単位からなる低熱膨張性ポリイミドは高いガラス転移温度を有している。従って、これらのポリイミドのフィルムを積層体の一部として用いることで、得られる基板の形状安定性を高めることができる。

【００３８】これらの材料を用いたポリイミドフィルムを重ねて加熱圧着し、または、複数回コーティングして、膜厚５００μm以上の積層体を作製する。積層体の熱膨張率は、用いる２種類以上のポリイミドの分子構造とそれらのフィルムを積層する際の比率を変えることで、最も低熱膨張成分のポリイミドフィルムの熱膨張係数と、最も高熱膨張成分のポリイミドフィルムの熱膨張係数との範囲内で、任意に制御することができる。

【００３９】

【実施例】以下、いくつかの実施例を用いて本発明をさらに詳しく説明するが、本発明はこれらの実施例に限定されるものではない。

【００４０】以下の各実施例において、作製したポリイミド積層体の平均表面粗さ（Ｒａ）は表面粗さ計を用い、積層体表面の５点を無作為に選んだ測定カ所で測定長さ３mm、測定針加重２５ｍｇの条件で測定した平均値として求めた。また、ポリイミド積層体の熱膨張係数は作製した積層体を長さ３mm、幅５mmの大きさに切り出し、熱機械試験機に取り付けて圧縮モードで５℃／分の速度で昇温し、５０℃から３００℃までの平均熱膨張係数として求めた。また、ポリイミド積層体上に形成したポリイミド膜の複屈折は、プリズムカップリング法を用いて測定した波長１．３μｍでの、基板面に平行な偏波方向の屈折率（n_{TE}）と、基板面に垂直な偏波方向の屈折率（n_{TM}）との差として、求めた。

【００４１】（実施例１）ロール延伸法により作製した

６５μｍのポリイミドフィルム（日本電信電話株式会社製；商品名ＦＬＵＰＩ－０１）からなるポリイミド層Ａを１０層重ね合わせて加熱プレス機に挟み、４０ｋｇ／ｃm^2の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の平均表面粗さ（Ｒａ）は９６５Åであり、面方向の熱膨張係数は８×１０$^{-5}$／℃であった。

【００４２】そして、この積層体上に前記構造式（１）で表される繰り返し単位からなるポリイミドの前駆体溶液をスピンコートした後、３８０℃で１時間の熱処理を行い、前記ポリイミド積層体上に膜厚８μｍのポリイミド膜（平面光導波路）を得た。このポリイミド膜の複屈折は０．００１以下であった。

【００４３】（実施例２）前記厚さ６５μｍのポリイミド層Ａを７層と、厚さ２５μｍの東レ・デュポン（株）製のポリイミドフィルム（商品名；１００ＫＪ）からなるポリイミド層Ｂを６層とを用意し、前者の７層のポリイミド層Ａの間に後者の６層のポリイミド層Ｂを交互に入れて積層し、これを加熱プレス機に挟み、４０ｋｇ／ｃm^2の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の平均表面粗さ（Ｒａ）は７５４Åであり、面方向の熱膨張係数は６×１０$^{-5}$／℃であった。

【００４４】そして、この積層体上に前記構造式（１）で表されるポリイミドの前駆体溶液をスピンコートした後、３８０℃で１時間の熱処理を行い、前記ポリイミド積層体上に膜厚８μｍのポリイミド膜（平面光導波路）を得た。このポリイミド膜の複屈折は０．００１以下であった。

【００４５】（実施例３）前記厚さ６５μｍのポリイミド層Ａと、前記厚さ２５μｍの東レ・デュポン（株）製ポリイミドフィルム（商品名；１００ＨＡ）からなるポリイミド層Ｂ’とを用い、順に、層Ａ×３，層Ｂ’×１、層Ａ×１，層Ｂ’×１，層Ａ×１，層Ｂ’×１，層Ａ×３というように、合計１１層重ね、これを加熱プレス機にはさみ、４０ｋｇ／ｃm^2の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の平均表面粗さ（Ｒａ）は４４Å、面方向の熱膨張係数は７×１０$^{-5}$／℃であった。

【００４６】そして、この積層体上に前記構造式（１）で表されるポリイミドの前駆体溶液をスピンコートした後、３８０℃で１時間の熱処理を行い、前記ポリイミド積層体上に膜厚８μｍのポリイミド膜（平面光導波路）を得た。このポリイミド膜の複屈折は０．００１であ

た。

【0047】（実施例4）前記構造式（1）で表される繰り返し単位からなるポリイミドを用いてロール延伸法により作製した厚さ６５μmのポリイミドフィルムからなるポリイミド層Aと、前記厚さ２５μmの東レ・デュポン（株）製ポリイミドフィルム（１００KJ）からなるポリイミド層Bと、厚さ５０μmの東レ・デュポン（株）製ポリイミドフィルム（商品名；カプトン）からなるポリイミド層Cとを用い、順に、層A×１，層B×７，層C×１，層B×７，層A×１というように、合計１７層重ね、これを加熱プレス機にはさみ、４０kg／cm^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の平均表面粗さ（Ra）は５０Å、面方向の熱膨張係数は５×１０$^{-5}$／℃であった。

【0048】そして、この積層体上に前記構造式（1）で表される繰り返し単位からなるポリイミドの前駆体溶液をスピンコートした後、３８０℃で１時間の熱処理を行い、前記ポリイミド積層体上に膜厚８μmのポリイミド膜（平面光導波路）を得た。このポリイミド膜の複屈折は０．００３であった。

【0049】（比較例）前記構造式（3）で表される繰り返し単位からなる厚さ５０μmの東レ・デュポン（株）製ポリイミドフィルム（商品名；カプトン）からなるポリイミド層Cと、厚さ２５μmの東レ・デュポン（株）ポリイミドフィルム（商品名；１００KJ）からなるポリイミド層Bとを用い、前者の７層の間に後者の６層を交互に入れて、加熱プレス機にはさみ、４０kg／cm^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の平均表面粗さ（Ra）は１６３５Å、面方向の熱膨張係数は３×１０$^{-5}$／℃であった。

【0050】そして、この積層体上に前記構造式（1）で表される繰り返し単位からなるポリイミドの前駆体溶液をスピンコートした後、３８０℃で１時間の熱処理を行い、前記ポリイミド積層体上に膜厚８μmのポリイミド膜（平面光導波路）を得た。このポリイミド膜の複屈折は０．００６であった。

【0051】さらに上記実施例１～４では、高分子光導波路用基板の材料として前記構造式（1）で表される繰り返し単位からなる厚さ６５μmのポリイミドフィルムからなるポリイミド層を用いたが、前記構造式（2）で表される繰り返し単位からなるポリイミドを用いても、同様の結果が得られた。さらに、前記構造式（1）、（3）、（4）でそれぞれ表される繰り返し単位からなる重合ポリイミドを用いても、同様の結果が得られた。

【0052】次に、光部品用基板の熱膨張率を制御することを目的に行った実施例を示す。以下の実施例には、前記実施例１～４と同じ内容の実施例もあるが、前述のように、熱膨張率を制御する実施例であるとの観点から、省略せずに記載した。

【0053】（実施例5）前記構造式（1）で表される繰り返し単位からなるポリイミドを用いてロール延伸法により作製した厚さ６５μmのポリイミドフィルム（商品名；FLUPI－０１）からなるポリイミド層Aを１０層重ね合わせて加熱プレス機に挟み、４０kg／cm^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の面方向の熱膨張係数は８×１０$^{-5}$／℃であった。

【0054】（実施例6）前記厚さ６５μmのポリイミド層Aと、前記厚さ２５μmの東レ・デュポン（株）製ポリイミドフィルム（商品名；１００HA）からなるポリイミド層B’とを用い、順に、層A×３、層B’×１、層A×１、層B’×１、層A×１、層B’×１、層A×３というように、合計１１層重ね、これを加熱プレス機に挟み、４０kg／cm^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の面方向の熱膨張係数は７×１０$^{-5}$／℃であった。

【0055】（実施例7）前記厚さ６５μmのポリイミド層Aと、厚さ２５μmの東レ・デュポン（株）ポリイミドフィルム（商品名；１００KJ）からなるポリイミド層Bとを用い、前者の７層の間に後者の６層を交互に入れて積層し、これを加熱プレス機に挟み、４０kg／cm^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の面方向の熱膨張係数は６×１０$^{-5}$／℃であった。

【0056】（実施例8）ロール延伸法により作製した厚さ６５μmのポリイミド層Aと、前記厚さ２５μmの東レ・デュポン（株）製ポリイミドフィルム（商品名；１００KJ）からなるポリイミド層Bと、前記構造式（3）で表される繰り返し単位からなる厚さ５０μmの東レ・デュポン（株）製ポリイミドフィルム（商品名；カプトン）からなるポリイミド層Cを用いて、順に、層A×１、層B×７、層C×１、層B×７、層A×１というように、合計１７層重ね、これを加熱プレス機に挟み、４０kg／cm^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した

て、円板状のポリイミド積層体を得た。このポリイミド積層体の面方向の熱膨張係数は５×１０$^{-5}$℃であった。

【００５７】（実施例９）前記厚さ５０μmの東レ・デュポン（株）製ポリイミドフィルム（１００ＨＡ）からなるポリイミド層Ｂ’と、前記厚さ２５μmの東レ・デュポン（株）製ポリイミドフィルム（１００ＫＪ）からなるポリイミド層Ｂとを用い、前者の７層の間に後者の６層を交互に入れて積層し、これを加熱プレス機に挟み、４０ｋｇ／ｃｍ^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の面方向の熱膨張係数は４×１０$^{-5}$℃であった。

【００５８】（実施例１０）前記構造式（３）で表される繰り返し単位からなる厚さ２５μmの東レ・デュポン（株）製ポリイミドフィルム（カプトン）からなるポリイミド層Ｃと、厚さ２５μmの東レ・デュポン（株）製ポリイミドフィルム（１００ＫＪ）からなるポリイミド層Ｂとを用い、前者の７層の間に後者の６層を交互に入れて積層し、これを加熱プレス機に挟み、４０ｋｇ／ｃｍ^{2}の圧力下、１５０℃で５時間加熱後、さらに最大３９０℃まで昇温し、１時間保持した後、室温まで徐冷した。これを直径２インチに切り出して、円板状のポリイミド積層体を得た。このポリイミド積層体の面方向の熱膨張係数は３×１０$^{-5}$／℃であった。

【００５９】前述の実施例５～１０に示したように、用いた２種類以上のポリイミドフィルムの分子構造とそれらのフィルムを積層する際の比率を変えることにより、積層体の熱膨張率を３×１０$^{-5}$／℃から８×１０$^{-5}$／℃の範囲で制御できた。

【００６０】さらに、上記実施例５～１０では、高分子光導波路用基板として、前記構造式（１）、（３）で表される繰り返し単位からなるポリイミドフィルムからなるポリイミド層を用いたが、前記構造式（２）、（４）で表される繰り返し単位からなるポリイミドを用いても、同様の結果が得られた。さらに、前記構造式（１）～（４）でそれぞれ表される繰り返し単位からなる、それぞれイミド化合物を組み合わせて重合してなる共重合ポリイミドを用いても、同様の結果が得られた。

【００６１】

【発明の効果】以上説明したように、本発明の光部品用基板およびその製造方法によれば、表面粗さが小さく、かつ熱膨張係数が大きい光学用ポリイミドと近い熱膨張係数を有する光学用ポリイミド基板が作製でき、この基板上に作製した光学用ポリイミドの複屈折を低減できるため、偏波依存性が小さいポリイミド光導波路を作製できるという効果がある。

【００６２】また、本発明の光部品用基板の熱膨張率制御方法によれば、分子構造の相異なる２種類以上のポリイミドフィルムを加熱圧着または複数回コーティングし、用いるポリイミドの分子構造とフィルムを積層する際の比率を変えることにより、積層体の熱膨張率が制御可能であることが明らかとなり、この積層体を光部品や電子部品の基板として用いることで部品製造の歩留まり、部品の信頼性、性能を向上できるという効果がある。

フロントページの続き

(72)発明者　佐々木　重邦
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内

(72)発明者　松浦　徹
東京都武蔵野市御殿山一丁目１番３号　エヌ・ティ・ティ・アドバンステクノロジ株式会社内

(72)発明者　山本　二三男
東京都武蔵野市御殿山一丁目１番３号　エヌ・ティ・ティ・アドバンステクノロジ株式会社内

(72)発明者　横山　博一
愛知県東海市新宝町31番地の６　東レ・デュポン株式会社東海事業場内

(72)発明者　杉本　範巳
大阪市北区中之島３丁目４番18号　東レ・デュポン株式会社大阪本社内

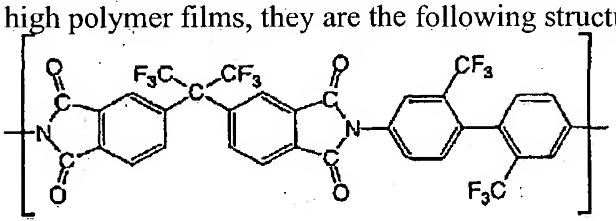
Ｆターム(参考)　2H047 KA02 PA01 PA02 PA28 QA05 TA00 TA42
4F071 AA66 AA66X AF43 AH19 BC02
4J043 PA02 PA04 PA08 PC146 QB16 QB26 RA35 SA06 SB01 SB03 TA22 TB01 UA132 UB062 UB121 UB401 VA021 VA041 ZA35 ZB21

* NOTICES *

JP-A 2001-4850

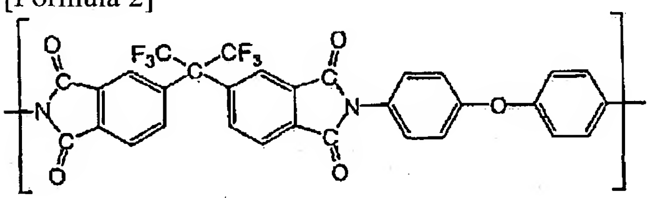
CLAIMS

[Claim(s)]
[Claim 1] The substrate for optical parts which consists of a layered product which comes to carry out heating sticking by pressure while two or more layer laminating of one kind or two kinds or more of high polymer films is carried out.
[Claim 2] The substrate for optical parts according to claim 1 characterized by the high polymer film which constitutes the aforementioned layered product being a polyimide.
[Claim 3] As one kind which constitutes the aforementioned layered product, or two kinds or more of high polymer films, they are the following structure expression (1) and (2):. [Formula 1]



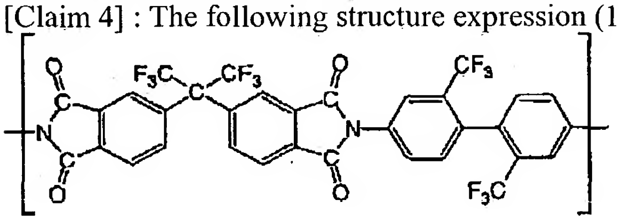
(1)

[Formula 2]



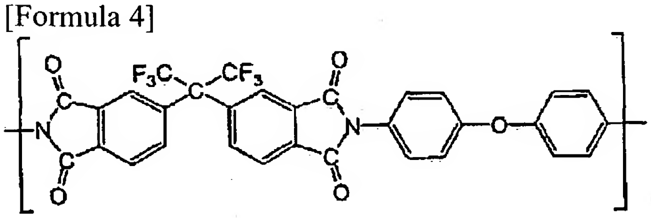
(2)

The substrate for optical parts according to claim 1 characterized by using the copolymerization polyimide film which consists of two or more kinds, the polyimide film which comes out and consists of either of the repeat units expressed, or the aforementioned repeat unit.
[Claim 4] : The following structure expression (1), (2) [Formula 3]



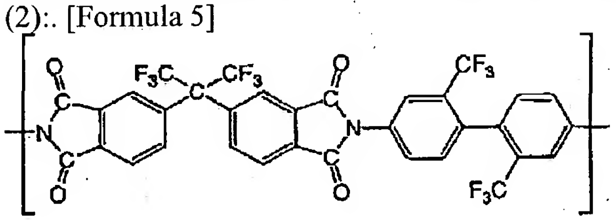
(1)

[Formula 4]



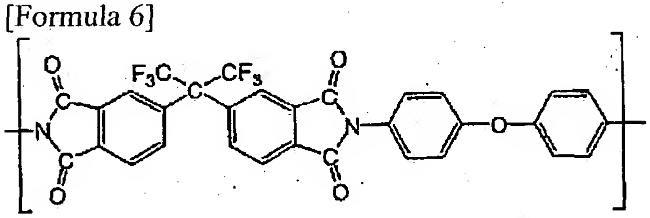
(2)

The copolymerization polyimide which consists of two or more kinds, the polyimide or the aforementioned repeat unit which comes out and consists of either of the repeat units expressed, is used. One kind or two kinds or more of polyimide films or copolymerization polyimide films are produced by the roll extending method or the solution applying method. The manufacture method of the substrate for optical parts characterized by unifying the polyimide film layered product which put one kind or the two aforementioned kinds or more of polyimide films or copolymerization polyimide films on two or more layers, and was put on two or more aforementioned layers by heating compression, and obtaining the substrate for optical parts.
[Claim 5] Two or more layer laminating of one kind or two kinds or more of polyimide films is chosen and carried out from two or more polyimide films with which coefficient of thermal expansion differs. It is the method of controlling the coefficient of thermal expansion of the substrate for optical parts obtained by carrying out heating sticking by pressure of this. The coefficient-of-thermal-expansion control method of the substrate for optical parts characterized by controlling the coefficient of thermal expansion of this substrate to a request value by changing the order of a laminating of one kind or the two aforementioned kinds or more of polyimide films or/, and the number of laminatings in case the laminating of two or more aforementioned polyimide films is carried out.
[Claim 6] As one kind of polyimide of the polyimides which constitute one kind or the two aforementioned kinds or more of polyimide films, they are the following structure expression (1) and (2):. [Formula 5]



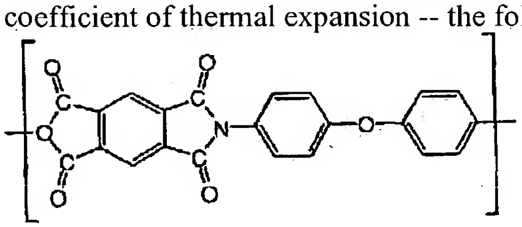
(1)

[Formula 6]



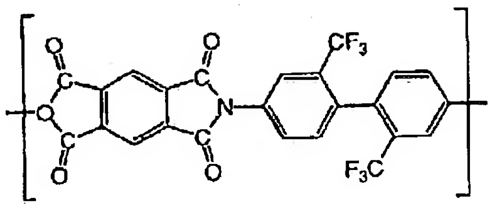
(2)

The coefficient-of-thermal-expansion control method of the substrate for optical parts according to claim 5 characterized by using the copolymerization polyimide which consists of two or more kinds, the polyimide or the aforementioned repeat unit which comes out and consists of a repeat unit expressed.
[Claim 7] as the low-fever expansion coefficient polyimide film for controlling the aforementioned coefficient of thermal expansion -- the following structure expression (3) or (4): [Formula 7]



(3)

[Formula 8]



(4)

The coefficient-of-thermal-expansion control method of the substrate for optical parts according to claim 6 characterized by using the film of a polyimide which comes out and consists of a repeat unit expressed.

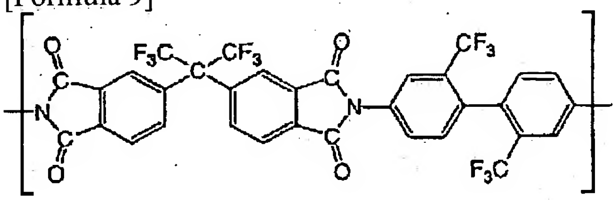
[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the substrate for optical parts which comes to carry out the laminating unification of the high polymer film of two or more layers, its manufacture method, and the coefficient-of-thermal-expansion control method of this substrate.
[0002]
[Description of the Prior Art] Development of the various parts for optical communication is desired with utilization of the optical transmission system by development of a low loss optical fiber. Moreover, establishment of the optical wiring technology of mounting these light parts with high density, especially optical-waveguide technology is desired.
[0003] Generally, conditions, such as that optical loss is small, that production of an optical waveguide is easy, that the refractive-index difference of a core and clad is controllable, and excelling in thermal resistance, are required of optical-waveguide material. As an optical-waveguide material, quartz system material is inquired until now most energetically. By the optical fiber, like, since light-transmission nature of a quartz is very good, when [finishing / an actual proof] it considers as an optical waveguide, in 1.3 micrometers, low optical-loss-ization of 0.1 or less dB/cm is attained for wavelength. however, large-area-izing which needs an elevated temperature is difficult at the time of production which needs a long time for production at the optical waveguide -- etc. -- there is a problem on manufacture
[0004] On the other hand, optical-waveguide formation is possible for plastics optical materials, such as a polymethylmethacrylate, at low temperature, and while there is the advantage in which a low price is expectable etc., they have the fault of being inferior to thermal resistance and moisture resistance. Moreover, although the polyimide was most excellent in thermal resistance in plastics, the conventional polyimide had the problem of being inferior to light-transmission nature.
[0005] Then, this invention persons have studied the polyimide optical material excellent in light-transmission nature by examining the chemical structure of a polyimide. This invention persons clarify the fluoridation polyimide which was excellent in JP,3-72528,A at light-transmission nature. Furthermore, in JP,4-8734,A, it is shown clearly by copolymerizing this fluoridation polyimide that refractive-index control required for formation of an optical waveguide is possible. Moreover, about the optical waveguide using this fluoridation polyimide, it clarifies in JP,4-9807,A, the 4-235505 official report, and the 4-235506 official report. Thus, the plastics optical waveguide which was excellent in thermal resistance with the polyimide excellent in light-transmission nature is realized.
[0006] However, there are some problems also in a polyimide optical waveguide. For example, while the polyimide is excellent in thermal resistance, it also has the field of being easy to carry out orientation of the aromatic ring in the chemical structure. This can say that it is easy to discover a birefringence, when it sees as an optical material. The birefringence itself is a property desirable as an optical material in a certain case, and, in a certain case, it serves as a property which is not desirable. Moreover, the same thing can be said when it sees as a charge of optical-waveguide material. For example, it is better not to have a birefringence to guide the light of non-polarization, although it is better for there to be a

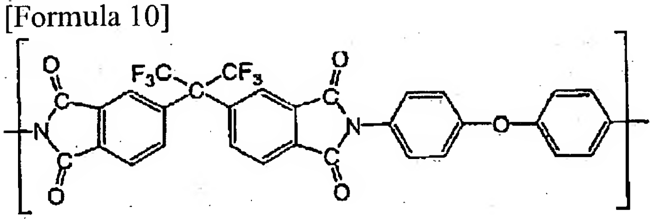
birefringence to guide waves, saving the plane of polarization of the linearly polarized light. Thus, it is expected that a birefringence is controllable at any cost. By old examination of this invention persons, it found out doubling the coefficient of thermal expansion of a substrate, and the coefficient of thermal expansion of a polyimide, i.e., a low birefringence polyimide film being realizable by using a polyimide substrate as a substrate, about the low birefringence polyimide film among these (Japanese-Patent-Application-No. No. 187652 [seven to] specification). Thus, in producing optical parts, it is very effective and important technique to control the coefficient of thermal expansion of a substrate according to optical-waveguide material, in order to produce highly efficient optical parts.
[0007] Moreover, also in the circuit board of electronic parts, such as substrates and module substrates, such as LSI, and a prism substrate, it is expectable that controlling the coefficient of thermal expansion of a substrate reduces the stress of electronic parts, and it raises the yield and reliability of parts greatly according to the metallic material and insulating material which constitute a circuit.
[0008]
[Problem(s) to be Solved by the Invention] By the way, it became clear that there are the following troubles in the above-mentioned substrate for optical parts. That is, although low birefringence-ization could be realized when a polyimide film was formed on a polyimide substrate, the trouble of [to through] a pile for light produced the polyimide optical waveguide produced on this substrate. It is considered to be the cause that this is not the substrate to which the polyimide substrate was suitable for the optical use. Then, this invention persons showed clearly that it is applicable as a substrate for optics in the Japanese-Patent-Application-No. No. 187194 [nine to] specification by grinding the average of roughness height of the front face of the polyimide substrate started from the polyimide molding object produced by compression molding etc. to 500A or less. However, by this method, since the surface roughness was remarkable and the polyimide molding object immediately after molding had it, the polish for making a front face smooth took the long time, and it had the trouble that the manufacturing cost of a substrate became remarkably high. [large]
[0009] Moreover, as mentioned above, although it was the very effective method of improving the performance of the yield in manufacture of parts, or parts to control the coefficient of thermal expansion of the substrate of optical parts or lightning parts, it is a substrate using the material which can be equal to heat treatment required for production of optical parts (optical parts especially using the polyimide for optics), or electronic parts until now, and there was no substrate which can control the coefficient of thermal expansion simple.
[0010] Therefore, the 1st technical problem of this invention is to offer the substrate for optical parts which is excellent in surface smooth nature, and can produce the macromolecule substrate for macromolecule optical waveguides whose coefficient of thermal expansion is less than [more than 4x10-5/degree-C1.2x10-4/degree C] simple, and its manufacture method.
[0011] Moreover, the 2nd technical problem of this invention is to offer the method of controlling the coefficient of thermal expansion of the substrate of optical parts or electronic parts according to part material.
[0012]
[Means for Solving the Problem] The layered product from which a front face carries out the laminating of the smooth macromolecule thin film, and is obtained has good surface smooth nature, and this invention persons traced that this layered product could apply as a substrate for optical parts, as a result of considering production of the macromolecule substrate for optical parts wholeheartedly. Furthermore, the substrate which this invention persons use for optical parts, especially a polyimide optical waveguide, As a result of examining wholeheartedly the coefficient-of-thermal-expansion control method of the substrate of electronic parts, the layered product which piled these up in suitable sequence is produced using two or more kinds of polyimide films with which one kind differs from a coefficient of thermal expansion. It traced that it showed clearly that the coefficient of thermal expansion of the substrate of optical parts or electronic parts is controllable in the broad range, and this layered product could apply as a substrate for optical parts or electronic parts by changing the chemical structure of a polyimide, and the composition of a laminating, using this as a substrate. this invention is accomplished

based on these knowledge.
[0013] That is, if this invention is outlined, the substrate for optical parts of the claim 1 of this invention will be characterized by the bird clapper from the layered product which comes to carry out heating sticking by pressure while two or more layer laminating of one kind or two kinds or more of high polymer films is carried out.
[0014] Moreover, the substrate for optical parts of the claim 2 of this invention is characterized by the high polymer film which constitutes the aforementioned layered product being a polyimide in the substrate for optical parts of the aforementioned claim 1.
[0015] Moreover, the substrate for optical parts of the claim 3 of this invention is the following structure expression (1) and (2): as one kind which constitutes the aforementioned layered product in the substrate for optical parts of the aforementioned claim 1, or two kinds or more of high polymer films. [0016]
[Formula 9]



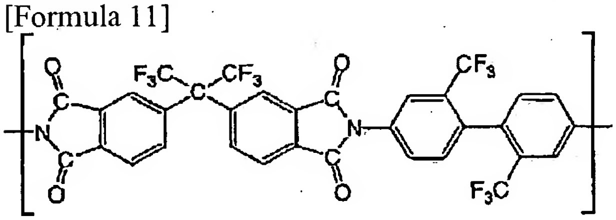
(1)

[0017]
[Formula 10]



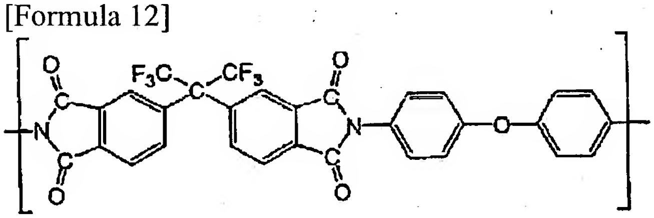
(2)

[0018] It is characterized by using the film of a copolymerization polyimide which consists of two or more kinds, the film of a polyimide which comes out and consists of either of the repeat units expressed, or the aforementioned repeat unit.
[0019] Moreover, the manufacture method of the substrate for optical parts of the claim 4 of this invention is the following structure expression (1) and (2):. [0020]
[Formula 11]



(1)

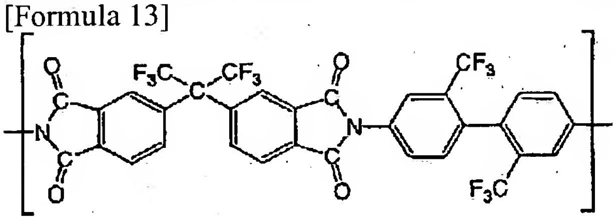
[0021]
[Formula 12]



(2)

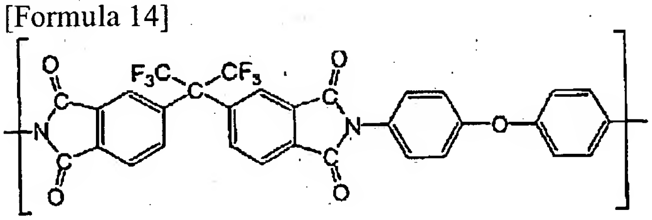
[0022] The copolymerization polyimide which consists of two or more kinds, the polyimide or the aforementioned repeat unit which comes out and consists of either of the repeat units expressed, is used. One kind or two kinds or more of polyimide films or copolymerization polyimide films are produced by the roll extending method or the solution applying method. It is characterized by unifying the polyimide

film layered product which put one kind or the two aforementioned kinds or more of polyimide films or copolymerization polyimide films on two or more layers, and was put on two or more aforementioned layers by heating compression, and obtaining the substrate for optical parts.
[0023] Furthermore, the coefficient-of-thermal-expansion control method of the substrate for optical parts of the claim 5 of this invention Two or more layer laminating of one kind or two kinds or more of polyimide films is chosen and carried out from two or more polyimide films with which coefficient of thermal expansion differs. It is the method of controlling the coefficient of thermal expansion of the substrate for optical parts obtained by carrying out heating sticking by pressure of this. In case the laminating of two or more aforementioned polyimide films is carried out, it is characterized by controlling the coefficient of thermal expansion of this substrate to a request value by changing the order of a laminating of one kind or the two aforementioned kinds or more of polyimide films or/, and the number of laminatings.
[0024] Moreover, the coefficient-of-thermal-expansion control method of the substrate for optical parts of the claim 6 of this invention is the following structure expression (1) and (2): as one kind of polyimide of the polyimides which constitute one kind or the two aforementioned kinds or more of polyimide films in the control method of the aforementioned claim 5. [0025]
[Formula 13]



(1)

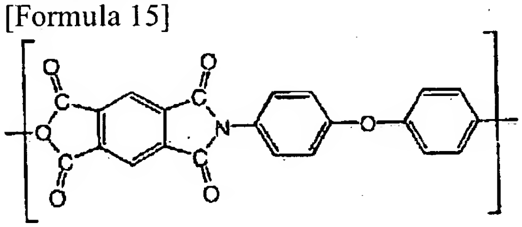
[0026]
[Formula 14]



(2)

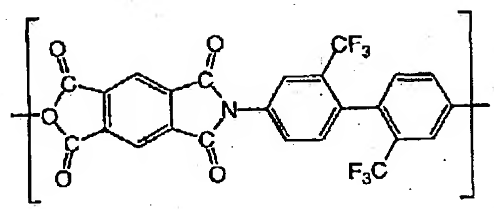
[0027] It is characterized by using the copolymerization polyimide which consists of two or more kinds, the polyimide or the aforementioned repeat unit which comes out and consists of a repeat unit expressed.

[0028] Moreover, the coefficient-of-thermal-expansion control method of the substrate for optical parts of the claim 7 of this invention is the following structure expression (3) or (4): as a low-fever expansion coefficient polyimide film for controlling the aforementioned coefficient of thermal expansion in the control method of the aforementioned claim 6. [0029]
[Formula 15]



(3)

[0030]
[Formula 16]



(4)

[0031] It is characterized by using the film of a polyimide which comes out and consists of a repeat unit expressed.
[0032]
[Embodiments of the Invention] Hereafter, this invention is explained concretely.
[0033] The macromolecule thin film used for the substrate for optical parts of this invention can use the thin film film which was excellent in the uniform thickness obtained by roll extension or the solution applying method at surface smooth nature. About the quality of the material of a macromolecule thin film, if thickness is possible for thin film formation of about 10 micrometers or more and it is the material in which a laminating is possible by technique, such as heating sticking by pressure and multilayering, there will be especially no limit. however, the viewpoint of the thermal stability of a substrate to a polyimide this macromolecule thin film material as a material of a layered product which it is good and is further used for a polyimide optical waveguide The copolymerization polyimide film which comes to carry out a polymerization combining the imido compound expressed with the polyimide film or the aforementioned structure expression which consists of a repeat unit expressed with the aforementioned structure expression (1) and (2) from a viewpoint [material / optical-waveguide] of coefficient-of-thermal-expansion adjustment, Or the polyimide film whose coefficient of thermal expansion is less than [more than 4x10-5/degree-C1.2x10-4/degree C] is desirable. It is because it is necessary to bear the temperature when planning forming a polyimide film on the polyimide substrate produced with these polyimide films about thermal resistance, and for that forming heat imide from a polyamide acid to a polyimide. Moreover, since the coefficient of thermal expansion of an optical waveguide which consists of a polyimide film formed on a substrate about a coefficient of thermal expansion is 8x10-5/degree C in general, in order to prevent the strain of an optical waveguide, it is because it is necessary to double the coefficient of thermal expansion of an optical-waveguide portion and a substrate portion to some extent. When the coefficient of thermal expansion of a substrate separates from the range not more than more than 4x10-5/degree-C1.2x10-4/degree C, the big strain based on the coefficient-of-thermal-expansion difference of an optical-waveguide portion and a substrate portion will be produced, and ablation and a crack will be caused to an optical waveguide, and the fault that the birefringence of an optical waveguide becomes remarkably large will be produced.
[0034] Heating sticking by pressure of the macromolecule thin film using such material is carried out in piles, or multiple-times coating is carried out and the layered product of 500 micrometers or more of thickness is produced.
[0035] In addition, as a polyimide film which constitutes the aforementioned layered product, in order to make large the control range of the coefficient of thermal expansion, it is desirable to use the polyimide which a coefficient of thermal expansion becomes from the repeat unit expressed with aforementioned structure expression (1) or (2) also in a polyimide as a high temperature expansion component. [very large] Moreover, it is desirable to use the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1) also from a viewpoint of adjustment with optical-waveguide material as a material of a layered product used for a polyimide optical waveguide.
[0036] Moreover, as a polyimide film of the 2nd kind of low-fever expansion components, heating sticking by pressure after film production and the laminating of a film is possible, if it is a polyimide with a coefficient of thermal expansion smaller than the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1), there is especially no limit of the molecular structure and use of a commercial polyimide film is also possible for it. For example, the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (3) has high

versatility, and it is suitable for it as a polyimide material of a low-fever expansion component. Moreover, the control of the coefficient of thermal expansion of a layered product substrate in the latus range is still attained by using the polyimide which has low-fever expansibility further as a polyimide of the 2nd component. The polyimide by which the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (4) as such a thing is suitably compounded from a following acid anhydride and a following diamine in addition to it is mentioned. As an acid anhydride, pyromellitic acid 2 anhydride, biphenyl tetracarboxylic dianhydride, benzophenone tetracarboxylic dianhydride, etc. can be mentioned. as a diamine The p phenylenediamine, meta-phenylenediamine, 2, and 2'-dimethyl -4, a 4'-diamino biphenyl, A 3 and 3'-diamino -4, 4'-biphenyl, 2, and 2'-ditrifluoromethyl -4, 4'-diamino biphenyl, 4, and 4'-diamino biphenyl and 4 or 4" of polyimides using the - diamino-P-terphenyl etc. can be mentioned.

[0037] Moreover, the low thermal-expansion nature polyimide which consists of a repeat unit expressed with the aforementioned structure expression (3) and (4) has the high glass transition temperature. Therefore, the configuration stability of the substrate obtained can be raised by using the film of these polyimides as a part of layered product.

[0038] Heating sticking by pressure of the polyimide film using such material is carried out in piles, or multiple-times coating is carried out and the layered product of 500 micrometers or more of thickness is produced. The coefficient of thermal expansion of a layered product is arbitrarily controllable with the coefficient of thermal expansion of the polyimide film of a low thermal-expansion component within the limits of the coefficient of thermal expansion of the polyimide film of a high temperature expansion component most changing the ratio at the time of carrying out the laminating of the molecular structures and those films of two or more kinds of polyimides to be used.

[0039]

[Example] Hereafter, although this invention is explained in more detail using some examples, this invention is not limited to these examples.

[0040] In each following example, it asked for the average surface roughness (Ra) of the produced polyimide layered product using the surface roughness meter as the average measured in the measurement mosquito place chosen at random [a layered product front face] five points on a measurement length of 3mm, and the conditions of 25mg of measurement needle loads. Moreover, the coefficient of thermal expansion of a polyimide layered product started the produced layered product in a length of 3mm, and the size with a width of face of 5mm, and attached it in the heat mechanical-test machine, and by the compress mode, the temperature up of it was carried out the speed for 5-degree-C/, and it asked for it as an average coefficient of thermal expansion from 50 degrees C to 300 degrees C. Moreover, the birefringence of the polyimide film formed on the polyimide layered product was searched for as a difference of the refractive index (nTE) of the direction of polarization parallel to a substrate side with a wavelength of 1.3 micrometers measured using prism coupling process, and the refractive index (nTM) of the direction of polarization perpendicular to a substrate side.

[0041] (Example 1) The roll extending method. You made it pile up ten layers of each other's polyimide layers A which consist of a polyimide film (; by Nippon Telegraph and Telephone CORP. tradename FLUPI- 01) with a thickness of 65 micrometers it is thin from the repeat unit expressed with the produced aforementioned structure expression (1), and it inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The average surface roughness (Ra) of this polyimide layered product was 965A, and the coefficient of thermal expansion of the direction of a field was 8x10-5/degree C.

[0042] And after carrying out the spin coat of the front main part solution of a polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1) on this layered product, heat treatment of 1 hour was performed at 380 degrees C, and the polyimide film (flat-surface optical waveguide) of 8 micrometers of thickness was obtained on the aforementioned polyimide layered product. The birefringence of this polyimide film was 0.001 or less.

[0043] (Example 2) Six layers are prepared for the polyimide layer B which turns into seven layers from the polyimide film (tradename; 100 KJ) with a thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co. in the polyimide layer A with an aforementioned thickness of 65 micrometers, and it is between the seven-layer former polyimide layers A. The six-layer latter polyimide layer B was put in by turns, and carried out the laminating, and this was inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The average surface roughness (Ra) of this polyimide layered product was 754A, and the coefficient of thermal expansion of the direction of a field was 6x10-5/degree C.
[0044] And after carrying out the spin coat of the front main part solution of the polyimide expressed with the aforementioned structure expression (1) on this layered product, heat treatment of 1 hour was performed at 380 degrees C, and the polyimide film (flat-surface optical waveguide) of 8 micrometers of thickness was obtained on the aforementioned polyimide layered product. The birefringence of this polyimide film was 0.001 or less.
[0045] Polyimide layer B' which consists of a polyimide film (tradename; 100 HA) with a polyimide layer [A] of with an aforementioned thickness of 65 micrometers and an aforementioned thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co. is used. (Example 3) In order, like a layer Ax3, layer B'x1, a layer Ax1, layer B'x1, a layer Ax1, layer B'x1, and a layer Ax3, a total of 11-layer pile and this are inserted into a hot press machine, and it is a maximum of 390 degrees C further after 5-hour heating at the bottom of the pressure of 2, and 150 degrees Ckg [40 //cm]. After carrying out the temperature up and holding for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of 44A and the direction of a field of the average surface roughness (Ra) of this polyimide layered product was 7x10-5/degree C.
[0046] And after carrying out the spin coat of the front main part solution of the polyimide expressed with the aforementioned structure expression (1) on this layered product, heat treatment of 1 hour was performed at 380 degrees C, and the polyimide film (flat-surface optical waveguide) of 8 micrometers of thickness was obtained on the aforementioned polyimide layered product. The birefringence of this polyimide film was 0.001.
[0047] (Example 4) The polyimide layer A which consists of a polyimide film with a thickness of 65 micrometers produced by the roll extending method using the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1) The polyimide layer B which consists of a polyimide film (100KJ) with an aforementioned thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co. The polyimide layer C which consists of a polyimide film (tradename; Kapton) with a thickness of 50 micrometers by Toray Industries E. I. du Pont de Nemours& Co. is used. in order like a layer Ax1, a layer Bx7, a layer Cx1, a layer Bx7, and a layer Ax1 A total of 17-layer pile and this were inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of 50A and the direction of a field of the average surface roughness (Ra) of this polyimide layered product was 5x10-5/degree C.
[0048] And after carrying out the spin coat of the front main part solution of a polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1) on this layered product, heat treatment of 1 hour was performed at 380 degrees C, and the polyimide film (flat-surface optical waveguide) of 8 micrometers of thickness was obtained on the aforementioned polyimide layered product. The birefringence of this polyimide film was 0.003.
[0049] (Example of comparison) The polyimide layer C which consists of a polyimide film (tradename; Kapton) with a thickness of 50 micrometers it is thin from the repeat unit expressed with the aforementioned structure expression (3) by Toray Industries E. I. du Pont de Nemours& Co. Using the

polyimide layer B which consists of a Toray Industries E. I. du Pont de Nemours& Co. polyimide film (tradename; 100 KJ) with a thickness of 25 micrometers, six layers of the latter were put in by turns among seven layers of the former, and it inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of 1635A and the direction of a field of the average surface roughness (Ra) of this polyimide layered product was 3x10-5/degree C.

[0050] And after carrying out the spin coat of the front main part solution of a polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1) on this layered product, heat treatment of 1 hour was performed at 380 degrees C, and the polyimide film (flat-surface optical waveguide) of 8 micrometers of thickness was obtained on the aforementioned polyimide layered product. The birefringence of this polyimide film was 0.006.

[0051] Furthermore, in the above-mentioned examples 1-4, although the polyimide layer which consists of a polyimide film with a thickness of 65 micrometers it is thin from the repeat unit expressed with the aforementioned structure expression (1) as a material of the substrate for macromolecule optical waveguides was used, even if it used the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (2), the same result was obtained. Furthermore, the same result was obtained even if it used the copolymerization polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1), (3), and (4), respectively and which comes to carry out a polymerization combining an imido compound, respectively.

[0052] Next, the example performed for the purpose of controlling the coefficient of thermal expansion of the substrate for optical parts is shown. Although there was also an example of the same contents as the aforementioned examples 1-4 among the following examples, it indicated as mentioned above from a viewpoint of being the example which controls coefficient of thermal expansion, without omitting.

[0053] (Example 5) The polyimide which consists of a repeat unit expressed with the aforementioned structure expression (1) is used, and it is the roll extending method. You made it pile up ten layers of each other's polyimide layers A which consist of a polyimide film (tradename; FLUPI- 01) with a thickness of 65 micrometers produced, and it inserted into the hot press machine, and after carrying out the temperature up ofkg [of a maximum of 390 degrees C / 40 //cm] further after 5-hour heating at 150 degrees C under the pressure of 2 and holding for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of the direction of a field of this polyimide layered product was 8x10-5/degree C.

[0054] Polyimide layer B' which consists of a polyimide film (tradename; 100 HA) with a polyimide layer [A] of with an aforementioned thickness of 65 micrometers and an aforementioned thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co. is used. (Example 6) In order, like a layer Ax3, layer B'x1, a layer Ax1, layer B'x1, a layer Ax1, layer B'x1, and a layer Ax3, a total of 11-layer pile and this are inserted into a hot press machine, and it is a maximum of 390 degrees C further after 5-hour heating at the bottom of the pressure of 2, and 150 degrees Ckg [40 //cm]. After carrying out the temperature up and holding for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of the direction of a field of this polyimide layered product was 7x10-5/degree C.

[0055] (Example 7) The polyimide layer B which consists of a Toray Industries E. I. du Pont de Nemours& Co. polyimide film (tradename; 100 KJ) with a polyimide layer [A] of with an aforementioned thickness of 65 micrometers and a thickness of 25 micrometers is used, and it is among seven layers of the former. Six layers of the latter were put in by turns, and carried out the laminating, and this was inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2

inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of the direction of a field of this polyimide layered product was 6x10-5/degree C.
[0056] (Example 8) The polyimide layer A with a thickness of 65 micrometers produced by the roll extending method The polyimide layer B which consists of a polyimide film (tradename; 100 KJ) with an aforementioned thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co. The polyimide layer C which consists of a polyimide film (tradename; Kapton) with a thickness of 50 micrometers it is thin from the repeat unit expressed with the aforementioned structure expression (3) by Toray Industries E. I. du Pont de Nemours& Co. is used. In order, a total of 17-layer pile and this were inserted into the hot press machine like a layer Ax1, the layer Bx7, the layer Cx1, the layer Bx7, and the layer Ax1, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of the direction of a field of this polyimide layered product was 5x10 to 5 degree C.
[0057] (Example 9) Polyimide layer B' which consists of a polyimide film (100HA) with an aforementioned thickness of 50 micrometers by Toray Industries E. I. du Pont de Nemours& Co., Using the polyimide layer B which consists of a polyimide film (100KJ) with an aforementioned thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co., six layers of the latter were put in by turns, and carried out the laminating among seven layers of the former, and this was inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of the direction of a field of this polyimide layered product was 4x10 to 5 degree C.
[0058] (Example 10) The polyimide layer C which consists of a polyimide film (Kapton) with a thickness of 25 micrometers it is thin from the repeat unit expressed with the aforementioned structure expression (3) by Toray Industries E. I. du Pont de Nemours& Co. Using the polyimide layer B which consists of a polyimide film (100KJ) with a thickness of 25 micrometers by Toray Industries E. I. du Pont de Nemours& Co., six layers of the latter were put in by turns, and carried out the laminating among seven layers of the former, and this was inserted into the hot press machine, and the bottom of the pressure of 40 kg/cm2, and after carrying out the temperature up of a maximum of 390 degrees C further and holding after 5-hour heating at 150 degrees C for 1 hour, it cooled slowly to the room temperature. This was started in diameter of 2 inches, and the disc-like polyimide layered product was obtained. The coefficient of thermal expansion of the direction of a field of this polyimide layered product was 3x10-5/degree C.
[0059] As shown in the above-mentioned examples 5-10, the coefficient of thermal expansion of a layered product was controllable in 3x10-5/degree C to 8x10-5/degree C by changing the ratio at the time of carrying out the laminating of those films to the molecular structure of two or more kinds of used polyimide films.
[0060] Furthermore, although the polyimide layer which consists of a polyimide film which consists of a repeat unit expressed with the aforementioned structure expression (1) and (3) as a substrate for macromolecule optical waveguides was used in the above-mentioned examples 5-10, the same result was obtained even if it used the polyimide which consists of a repeat unit expressed with the aforementioned structure expression (2) and (4). Furthermore, the same result was obtained even if it used the copolymerization polyimide which consists of a repeat unit expressed with aforementioned structure-expression (1) - (4), respectively and which comes to carry out a polymerization combining an imido compound, respectively.
[0061]
[Effect of the Invention] Since the birefringence of the polyimide for optics which could produce the polyimide substrate for optics which has a polyimide for optics with a large coefficient of thermal expansion and a near coefficient of thermal expansion small, and surface roughness produced on this

substrate can be reduced according to the substrate for optical parts and its manufacture method of this invention as explained above, it is effective in the ability of a polarization dependency to be able to produce a small polyimide optical waveguide.

[0062] Moreover, the thing for which the ratio at the time of carrying out the laminating of the molecular structure and the film of the polyimide which sticks [heating-] by pressure or coats [multiple-times-], and uses two or more kinds of polyimide films with which the molecular structure is different from each other according to the coefficient-of-thermal-expansion control method of the substrate for optical parts of this invention is changed. It becomes clear for the coefficient of thermal expansion of a layered product to be controlled, and it is effective in the ability to improve the yield of part manufacture, the reliability of parts, and a performance by using this layered product as a substrate of optical parts or electronic parts.

[Translation done.]